

## BOILER FEED-WATER

In the matter of economical production of steam it is not sufficient to obtain a supply of heat in the furnace at minimum cost by careful selection of fuel and its complete combustion under properly regulated conditions of air-supply. It is necessary, further, that this heat should be transferred to the boiler at the highest possible efficiency. In this connection regard must be had to the quality of the water used for supplying the boiler, since this, if unsatisfactory, may add to the cost of steam-raising, not only directly by producing within the boiler incrustations that hinder the passage of heat from the furnace, but indirectly through the added expense of removing these deposits from time to time, as well as through deterioration resulting from corrosion of plates and fittings.

Impurities in Water.—Water that is chemically pure, that is to say containing neither matter in suspension nor in solution, is best suited for the work of steam-raising; but this ideal is not easily attained in practice, and it is important to notice that the nearest approach to it is not always a good second best. When impurities are present, their nature as well as their quantity must be taken into account. Oil is not uncommon as a contamination of water from surface condensers, and when passed into the boiler has been known to produce damage out of proportion to its actual amount. Freshly fallen rain-water, if collected in a clean tank, makes excellent boiler feed, but left in contact with decaying vegetation for a time may develop an actively corrosive character from the presence of organic and carbonic acids. Such a water may be more harmful than one containing many grains of saline matter and might be improved by adding to the impurities already in it. In addition to air and carbonic acid, waters that have been in contact with rocks and soil contain in suspension and in solution solid matter derived from these. The suspended matter may be got rid of by settling, or, if necessary, by filtration. In most practical water-supplies the quantity of the suspended matter is small in comparison with what may be present in

solution, and its removal presents less difficulty. The solid matters dissolved in natural waters consist usually of organic matter, silica, iron, and alumina in small quantities, while carbonate and sulphate of lime, carbonate, sulphate, and chloride of magnesia, and chloride of sodium may be present in amounts varying from traces up to many grains per gallon. The carbonates of lime and magnesia are not soluble to any great extent in pure water ( $\text{CaCO}_3$  11 gr. and  $\text{MgCO}_3$  8 gr. per gallon at 60° F.), but are dissolved in the form of bicarbonates,  $\text{CaCO}_3 \cdot \text{H}_2\text{CO}_3$  and  $\text{MgCO}_3 \cdot \text{H}_2\text{CO}_3$ , by the carbonic acid already in solution in the water. Natural waters are sometimes grouped according to their origin as rain, river, shallow well, deep well, spring, and mine water and finally sea-water, but such a classification has little practical value for the engineer, since, if the extreme members be excluded, the other categories show wide differences—the result of varying composition in rocks and soils through which the water has passed, and in some cases of local